

CLAIMS

We claim:

- 1 1. A measurement device comprising:
 - 2 an acousto-optic modulator adapted to receive a laser beam
 - 3 and modulate the laser beam based upon one or more frequencies
 - 4 of a received input signal to generate one or more modulated
 - 5 laser beams, wherein the input signal is comprised of one or
 - 6 more signals corresponding to one or more of the frequencies;
 - 7 a multiple-pitch grating adapted to receive one or more of
 - 8 the modulated laser beams and provide an output laser beam;
 - 9 a photodetector adapted to receive the output laser beam
 - 10 and provide an output signal;
 - 11 at least one filter adapted to filter the output signal at
 - 12 one or more of the frequencies of the input signal and provide a
 - 13 corresponding filtered output signal; and
 - 14 at least one phase detector adapted to determine a phase
 - 15 difference between a phase of the filtered output signal and a
 - 16 phase of a corresponding one of the signals of the input signal,
 - 17 wherein the phase difference corresponds to a position
 - 18 measurement of the multiple-pitch grating.
- 1 2. The measurement device of Claim 1, further comprising
- 2 a lens adapted to direct the one or more modulated laser beams
- 3 from the acousto-optic modulator to the multiple-pitch grating.

1 3. The measurement device of Claim 2, wherein the lens
2 recombines a zero order diffraction laser beam and at least one
3 first order diffraction laser beam from the acousto-optic
4 modulator onto the multiple-pitch grating.

1 4. The measurement device of Claim 1, further comprising
2 a laser adapted to provide the laser beam to the acousto-optic
3 modulator.

1 5. The measurement device of Claim 1, wherein the input
2 signal comprises a first signal having a first frequency and a
3 second signal having a second frequency, the at least one filter
4 comprises a first bandpass filter centered at the first
5 frequency to filter the output signal and provide a first
6 filtered output signal and a second bandpass filter centered at
7 the second frequency to filter the output signal and provide a
8 second filtered output signal, and the at least one phase
9 detector comprises a first phase detector adapted to provide a
10 first phase difference between the first filtered output signal
11 and the first signal and a second phase detector adapted to
12 provide a second phase difference between the second filtered
13 output signal and the second signal.

1 6. The measurement device of Claim 5, wherein the first
2 phase difference and the second phase difference provide
3 relative position measurements of the multiple-pitch grating,
4 and a difference between the first and second phase difference
5 provides an absolute position measurement.

1 7. The measurement device of Claim 5, further comprising:
2 a first signal source adapted to provide the first signal;
3 a second signal source adapted to provide the second
4 signal; and
5 a summer adapted to sum the first and second signal sources
6 and provide the input signal.

1 8. The measurement device of Claim 1, wherein the
2 multiple-pitch grating comprises a sinusoidally-modulated
3 amplitude grating having two or more simultaneous spatial
4 frequencies.

1 9. The measurement device of Claim 1, wherein the
2 multiple-pitch grating comprises two or more separate gratings
3 on one substrate.

1 10. A grating comprising:
2 a first pitch period providing a first spatial frequency;
3 and
4 at least a second pitch period providing at least a second
5 spatial frequency, wherein the grating optically encodes a laser
6 beam having a spatial frequency corresponding to at least one of
7 the spatial frequencies of the grating.

1 11. The grating of Claim 10, wherein the first pitch
2 period and the at least second pitch period are all distinctly
3 positioned separately on the grating.

1 12. The grating of Claim 10, wherein the first pitch
2 period and the at least second pitch period are additively
3 combined on the grating.

1 13. The grating of Claim 10, wherein the grating comprises
2 part of an optical encoder position measurement device, and the
3 grating optically encodes position information onto a laser beam
4 passing through the grating, which can be decoded to determine a
5 relative or an absolute position of the grating.

1 14. A method of obtaining position information of a
2 grating, the method comprising:

3 receiving a laser beam;

4 directing the laser beam to provide two or more spatial
5 frequencies;

6 passing the laser beams with the spatial frequencies
7 through the grating having multiple-pitches to provide one or
8 more output laser beams with encoded position information; and

9 decoding the one or more output laser beams to determine a
10 position of the grating.

1 15. The method of Claim 14, wherein the grating comprises
2 a sinusoidally-modulated amplitude grating having two or more
3 spatial frequencies.

1 16. The method of Claim 14, wherein the position of the
2 grating is an absolute position measurement.

1 17. The method of Claim 14, wherein the grating is formed
2 as part of or attached to an object whose position information
3 is desired.

1 18. The method of Claim 14, wherein the decoding comprises
2 converting the one or more output laser beams to an electrical
3 signal whose phase information corresponds to the position of
4 the grating.

1 19. The method of Claim 14, wherein the two or more
2 spatial frequencies of the laser beam also has corresponding
3 temporal frequencies.

1 20. A system comprising:
2 a grating having two or more pitches;
3 means for providing to the grating one or more laser beams
4 with spatial frequencies corresponding to one or more of the
5 pitches of the grating; and
6 means for decoding an output laser beam resulting from the
7 one or more laser beams passing through the grating to provide
8 one or more output signals, wherein the one or more output
9 signals provide position information of the grating.

1 21. The system of Claim 20, wherein the means for
2 providing comprises an acousto-optic modulator adapted to
3 receive a laser beam and an input signal with one or more
4 distinct frequencies to generate the spatial frequencies and
5 associated temporal frequencies of the laser beams.

1 22. The system of Claim 20, wherein the means for
2 providing comprises two or more modulators which provide
3 distinguishable laser beams.

1 23. The system of Claim 20, wherein the grating comprises
2 a sinusoidally-modulated amplitude grating having two or more
3 simultaneous spatial frequencies.

1 24. The system of Claim 20, wherein the means for decoding
2 comprises:

3 a photodetector adapted to convert the output laser beam to
4 an electrical output signal;

5 at least one filter to filter the output signal; and

6 at least one phase detector to determine the position
7 information of the grating based upon a phase relationship of
8 the output signal.